WE CLAIM:

1. A method of sealing a vacuum membrane to a surface, comprising the steps of:

defining a vacuum zone on the surface;

placing a breather over the surface within said vacuum zone;

placing a membrane over said breather, said membrane covering said vacuum zone;

forming a vacuum seal between said membrane and the surface; and

covering said vacuum seal with a laminate release surface.

2. The method of claim 1, wherein said step of defining said vacuum zone comprises placing a double-stick tape on the surface at a boundary of said vacuum zone.

3. The method of claim 1, wherein said step of placing said breather comprises adhering said breather to the surface inside said vacuum zone.

4. The method of claim 1, wherein said step of forming said vacuum seal comprises sticking said membrane to an exposed side of a double stick tape adhered to the surface at a boundary of said vacuum zone.

5. The method of claim 1, wherein said step of forming said vacuum seal comprises covering an edge of said membrane with a seal tape, said seal tape adhering to said membrane and to the surface.

6. The method of claim 1, wherein said step of covering said vacuum seal comprises covering said vacuum seal with a teflon tape.

7. The method of claim 1, further comprising a step of:

applying a vacuum to an interior space between the surface and said membrane.

8. The method of claim 1, further comprising a step of:

holding said membrane on the surface over said vacuum zone by applying a vacuum underneath said membrane and over said surface.

9. The method of claim 8, wherein said holding step includes applying said vacuum through a vacuum port in said mandrel tool.

10. A method of forming individual vacuum zones on a lay-up surface of a mandrel tool, comprising the steps of:

defining a first vacuum zone on the lay-up surface;

defining a second vacuum zone on the lay-up surface;

placing a first breather over the lay-up surface within said first vacuum zone;

placing a second breather over the lay-up surface within said second vacuum zone;

placing a first membrane over said first breather, said first membrane covering said first vacuum zone;

placing a second membrane over said second breather, said second membrane covering said second vacuum zone;

forming a first vacuum seal between said first membrane and the lay-up surface;

forming a second vacuum seal between said second membrane and the lay-up surface;

covering said first vacuum seal with a first laminate release surface; and

covering said second vacuum seal with a second laminate release

surface.

11. The method of claim 10, further comprising a step of:

holding said first membrane to the lay-up surface at said first vacuum zone by applying a first vacuum to a first interior space between the lay-up surface and said first membrane, said first breather being within said first interior space.

12. The method of claim 10, further comprising a step of:

holding said second membrane to the lay-up surface at said second vacuum zone by applying a second vacuum to a second interior space between the lay-up surface and said second membrane, said second breather being within said second interior space.

13. The method of claim 10, further comprising a step of:

providing a rebate in the lay-up surface between said first vacuum seal and said second vacuum seal.

14. The method of claim 10, further comprising steps of:

laying up a composite laminate skin on said lay-up surface over said first membrane, said first laminate release surface, said second membrane, and said second laminate release surface; and

cutting said composite laminate skin between said first vacuum seal and said second vacuum seal.

15. The method of claim 10, wherein said step of defining said first vacuum zone comprises:

placing a double-stick tape on the lay-up surface at a first boundary of said first vacuum zone to be smoothly covered by a composite laminate skin; and

forming a conventional vacuum seal at a second boundary of said first vacuum zone not to be covered by said composite laminate skin.

16. A method of transferring an uncured composite laminate skin from a lay-up surface of a male mandrel tool to a female cure tool, comprising the steps of:

defining a first vacuum zone on the lay-up surface by applying a first double-stick tape to the lay-up surface;

defining a second vacuum zone on the lay-up surface by applying a second double-stick tape to the lay-up surface, wherein said first vacuum zone and said second vacuum zone are adjacent;

placing a first breather over the lay-up surface within said first vacuum zone;

placing a second breather over the lay-up surface within said second vacuum zone;

placing a first membrane over said first breather, said first membrane covering said first vacuum zone, and adhering said first membrane to said first double-stick tape;

placing a second membrane over said second breather, said second membrane covering said second vacuum zone, and adhering said second membrane to said second double-stick tape;

forming a first redundant vacuum seal between said first membrane and the lay-up surface by covering a first edge of said first membrane with a first seal tape, said first seal tape adhering to said first membrane and to the lay-up surface;

forming a second redundant vacuum seal between said second membrane and the lay-up surface by covering a second edge of said second membrane with a second seal tape, said second seal tape adhering to said second membrane and to the lay-up surface, wherein said second redundant vacuum seal is adjacent to said first redundant vacuum seal;

covering said first redundant vacuum seal with a first laminate release surface;

covering said second redundant vacuum seal with a second laminate release surface;

laying up a composite laminate skin on said lay-up surface over said first vacuum zone and over said second vacuum zone, wherein:

said composite laminate skin smoothly covers said first redundant vacuum seal and said second redundant vacuum seal adjacent to said first redundant vacuum seal; and

said composite laminate skin smoothly covers said first membrane and said first laminate release surface, said second membrane and said second laminate release surface.

17. The method of claim 16, further comprising steps of:

applying a first vacuum to said first vacuum zone, wherein said first vacuum is applied to a first interior space between the lay-up surface and said first membrane, said first breather being within said first interior space;

applying a second vacuum to said second vacuum zone, wherein said second vacuum is applied to a second interior space between the lay-up surface and said second membrane, said second breather being within said second interior space;

cutting said composite laminate skin between said first vacuum zone and said second vacuum zone, wherein said cutting step produces a first portion of said composite laminate skin over said first vacuum zone and a second portion of said composite laminate skin over said second vacuum zone;

holding said first membrane and said first portion to the lay-up surface at said first vacuum zone using said first vacuum; and

holding said second membrane and said second portion to the lay-up surface at said second vacuum zone using said second vacuum.

18. The method of claim 16, further comprising steps of:

providing a rebate in the lay-up surface between said first vacuum seal and said second vacuum seal; and

cutting said composite laminate skin over said rebate.

19. The method of claim 16, further comprising steps of:

cutting said composite laminate skin between said first vacuum zone and said second vacuum zone;

releasing said first vacuum; and

allowing a first portion of said composite laminate skin to drop into a cure tool.

20. The method of claim 16, further comprising steps of:

cutting said composite laminate skin between said first vacuum zone and said second vacuum zone, wherein said cutting step produces a first portion of said composite laminate skin over said first vacuum zone and a second portion of said composite laminate skin over said second vacuum zone;

orienting said mandrel tool so that said second vacuum zone and said second portion are disposed above a cure tool;

releasing said second vacuum; and

allowing said second portion of said composite laminate skin to drop into said cure tool.

21. A method of fabricating a composite laminate aircraft skin in multiple panels transferred from a lay-up surface of a mandrel tool to a plurality of cure tools having an aero surface tooled to an outer mold line, comprising the steps of:

laying up the composite laminate aircraft skin as a complete barrel section;

cutting the composite laminate aircraft skin into a plurality of panels;

transferring at least one panel of said plurality of panels individually and independently of all other of said plurality of panels from the lay-up surface of the mandrel tool to a first cure tool of said plurality of cure tools having an aero surface;

curing said at least one panel wherein the first cure tool defines and controls the outer mold line of said at least one panel; and

removing said at least one panel from the first cure tool.

22. The method of claim 21, wherein said cutting step comprises cutting the composite laminate aircraft skin into no more than two panels.

23. The method of claim 21, wherein said laying up step comprises:

providing a rebate in the lay-up surface;

defining a first vacuum zone on the lay-up surface on a first side of said rebate by applying a first double-stick tape to the lay-up surface;

defining a second vacuum zone on the lay-up surface on a second side of said rebate by applying a second double-stick tape to the lay-up surface;

placing a first breather over the lay-up surface within said first vacuum zone;

placing a second breather over the lay-up surface within said second vacuum zone;

placing a first membrane over said first breather, said first

membrane covering said first vacuum zone, and adhering said first membrane to said first double-stick tape;

placing a second membrane over said second breather, said second membrane covering said second vacuum zone, and adhering said second membrane to said second double-stick tape;

forming a first redundant vacuum seal between said first membrane and the lay-up surface by covering a first edge of said first membrane with a first seal tape, said first seal tape adhering to said first membrane and to the lay-up surface;

forming a second redundant vacuum seal between said second membrane and the lay-up surface by covering a second edge of said second membrane with a second seal tape, said second seal tape adhering to said second membrane and to the lay-up surface;

covering said first redundant vacuum seal with a first laminate release surface;

covering said second redundant vacuum seal with a second laminate release surface; and

laying up a composite laminate skin on said lay-up surface over said first vacuum zone and over said second vacuum zone, wherein:

said composite laminate skin smoothly covers said first membrane and said first laminate release surface, said second membrane and said second laminate release surface.

24. The method of claim 23, wherein said cutting step comprises

holding said first membrane to the lay-up surface at said first vacuum zone by applying a first vacuum to said first vacuum zone, wherein said first vacuum is applied to a first interior space between the lay-up surface and said first membrane, said first breather being within said first interior space;

holding said second membrane to the lay-up surface at said second vacuum zone by applying a second vacuum to said second vacuum

zone, wherein said second vacuum is applied to a second interior space between the lay-up surface and said second membrane, said second breather being within said second interior space;

cutting said composite laminate skin over said rebate between said first vacuum zone and said second vacuum zone, wherein said cutting produces a first portion of said composite laminate skin over said first vacuum zone and a second portion of said composite laminate skin over said second vacuum zone.

25. The method of claim 24, wherein said transferring step comprises

orienting said mandrel tool so that said first vacuum zone and said first portion are disposed above a first cure tool;

releasing said first vacuum;

allowing said first portion of said composite laminate skin to drop into said first cure tool;

orienting said mandrel tool so that said second vacuum zone and said second portion are disposed above a second cure tool;

releasing said second vacuum; and

allowing said second portion of said composite laminate skin to drop into said second cure tool.

26. A method of transferring an uncured composite laminate skin from a lay-up surface of a mandrel tool to a cure tool, comprising:

a step for forming a first low profile seal of a first membrane to a surface of a mandrel tool at a first vacuum zone;

a step for forming a second low profile seal of a second membrane to a surface of a mandrel tool at a second vacuum zone;

a step for smoothly laying up a composite laminate skin over said first vacuum zone and said second vacuum zone;

a step for separating said composite laminate skin into a first

portion over said first vacuum zone and a second portion over said second vacuum zone; and

a step for releasing said first portion individually of said second portion into a first cure tool.

27. The method of claim 26, wherein said step for forming a first low profile seal includes a step for adhering said first membrane to said surface.

28. The method of claim 26, wherein said step for forming a first low profile seal includes a step for providing a laminate release surface over said low profile seal.

29. The method of claim 26, wherein said step for releasing includes a step for orienting said mandrel tool to dispose said second portion above a second cure tool and releasing said second portion into said second cure tool.

30. A tool for manufacturing large aircraft parts, comprising:

a male mandrel tool having a lay-up surface; and

at least one vacuum zone defined on said lay-up surface.

31. The tool of claim 30 further comprising:

a low profile vacuum seal at a boundary of said at least one vacuum zone; and

a membrane covering said at least one vacuum zone wherein said low profile vacuum seal forms a vacuum seal between said membrane and said lay-up surface.

32. The tool of claim 30 further comprising:

a low profile vacuum seal at a boundary of said at least one vacuum zone; and

an automated tape laying machine, wherein said automated tape laying machine places a composite laminate material smoothly over said low profile vacuum seal.

33. A system for manufacturing large aircraft parts, comprising:

a multiple head automated tape laying machine;

a male mandrel lay-up tool having a lay-up surface with a plurality of vacuum zones defined on said lay-up surface; and

a plurality of female cure tools.

34. The system of claim 33 further comprising:

a first vacuum zone of said plurality of vacuum zones, said first vacuum zone having a first low profile vacuum seal at a first boundary of said first vacuum zone;

a second vacuum zone of said plurality of vacuum zones; said second vacuum zone having a second low profile vacuum seal at a second boundary of said second vacuum zone; and

a rebate that separates said first vacuum zone from said second vacuum zone.

35. The system of claim 33 further comprising:

a first vacuum zone of said plurality of vacuum zones, said first vacuum zone having a first low profile vacuum seal at a first boundary of said first vacuum zone;

a first membrane covering said first vacuum zone wherein said first low profile vacuum seal forms a first vacuum seal between said first membrane and said lay-up surface;

a second vacuum zone of said plurality of vacuum zones; said second vacuum zone having a second low profile vacuum seal at a second boundary of said second vacuum zone;

a second membrane covering second vacuum zone wherein said second low profile vacuum seal forms a second vacuum seal between said second membrane and said lay-up surface; and

a rebate that lies between said first low profile vacuum seal and said second low profile vacuum seal, wherein said multiple head automated tape laying machine places a composite laminate material smoothly over said first low profile vacuum seal, said rebate, and said second low profile vacuum seal without bridging.

36. A method for making composite panels for a fuselage, comprising the steps of:

placing a resin-impregnated tape on a mandrel to form a barrel that is substantially the shape of a fuselage section;

cutting the barrel into a plurality of panels on the mandrel;

transferring the panels one at a time from the mandrel to at least one cure tool;

curing at least one of the panels on the cure tool to form a cured composite panel; and

removing the cured composite panel from the cure tool, wherein the cure tool defines and controls the outer mold line of the panel.

37. The method of claim 36, wherein said cutting step comprises cutting the barrel into no more than two panels and the plurality of panels includes two panels.

38. The method of claim 36, wherein said cutting step comprises cutting the barrel into four panels, wherein said panels are quarter-section panels.

39. The method of claim 36, wherein multiple tape laying heads operating simultaneously perform said step of placing a resin-impregnated tape on the mandrel.

40. The method of claim 36, further comprising a step of defining a plurality of vacuum zones on the mandrel, wherein each vacuum zone corresponds uniquely to a distinct panel of the plurality of panels.

41. The method of claim 36, further comprising a step of holding all other panels, except the panel being transferred, onto the mandrel.

42. The method of claim 40, further comprising a step of holding all other panels, except the panel being transferred, onto the mandrel by maintaining vacuum in all other vacuum zones corresponding to all other panels except the panel being transferred, and releasing vacuum only in the vacuum zone corresponding to the panel being transferred.

43. A method for making composite panels for a fuselage, comprising the steps of:

inserting a mandrel, the mandrel having the composite panels held onto the mandrel, into a cure tool;

transferring one composite panel from the mandrel to the cure tool while holding a second composite panel on the mandrel; and

removing the mandrel from the cure tool.

44. The method of claim 43, further comprising steps of:

placing a resin-impregnated tape on a mandrel to form a composite barrel that is substantially the shape of a fuselage section; and

cutting the composite barrel to define at least one composite panel

of an uncured part.

45. The method of claim 43, further comprising steps of:

bagging the composite panel on the cure tool;

curing the composite panel; and

removing the cured composite panel from the cure tool.

46. A composite panel for an aircraft, said composite panel being produced by:

placing a resin-impregnated tape on a mandrel to form a barrel that is substantially the shape of a fuselage section;

cutting the barrel into at least two panels on the mandrel;

transferring the panels one at a time from the mandrel to at least one cure tool;

curing at least one of the panels on the cure tool to form a cured composite panel; and

removing the cured composite panel from the cure tool, wherein the at least one cure tool defines and controls the outer mold line of the composite panel.

47. An uncured composite laminate adapted for forming into an aircraft fuselage panel, said composite laminate being produced by:

placing a resin-impregnated tape on a mandrel to form a barrel that is substantially the shape of a fuselage panel;

cutting the barrel into at least two panels on the mandrel; and

transferring the panels one at a time from the mandrel to at least one cure tool.

48. The uncured composite laminate of claim 47, wherein:

said uncured composite laminate is cured on the cure tool to form

a cured composite aircraft fuselage panel, wherein the cure tool defines and controls the outer mold line of the cured composite aircraft fuselage panel; and

the cured composite aircraft fuselage panel is removed from the cure tool.

49. A system for manufacturing large composite aircraft parts, comprising:

a mandrel defining a forming surface in essentially the shape of an entire fuselage section ; and

at least one tape laying machine associated with said mandrel for laying composite tape onto said forming surface to define the fuselage section.

50. The system of claim 49 wherein:

said mandrel has at least one vacuum zone defined on said forming surface;

51. The system of claim 50 further comprising:

a membrane covering said at least one vacuum zone;

a low profile vacuum seal at a boundary of said vacuum zone;

wherein said low profile vacuum seal forms a vacuum seal between said membrane and said forming surface; and wherein

said tape laying machine places a composite laminate material smoothly over said low profile vacuum seal.

52. The system of claim 49 further comprising:

at least one female cure tool wherein said female cure tool defines and controls the outer mold line of the fuselage section.

53. The system of claim 52 further comprising:

an autoclave capable of accepting said female cure tool and the

fuselage section.

54. The system of claim 50 further comprising:

a first vacuum zone having a first low profile vacuum seal at a first boundary of said first vacuum zone;

a second vacuum zone having a second low profile vacuum seal at a second boundary of said second vacuum zone;

a rebate that separates said first vacuum zone from said second vacuum zone; and

a cutting machine that cuts the fuselage section over said rebate and into panels of the fuselage section.

55. The system of claim 49, further comprising:

a plurality of female cure tools; and wherein

said tape laying machine is a multiple head automated tape laying machine;

said forming surface of said mandrel has a plurality of vacuum zones defined on said forming surface.